

1 **DIRECT-LIGHT ILLUMINATING BACKLIGHT UNIT WITH**
2 **SHIELDING MASK FOR A LIQUID CRYSTAL DISPLAY**

3 BACKGROUND OF THE INVENTION

4 1. Field of the Invention

5 The present invention relates to a direct-light illuminating backlight
6 unit with shielding mask for a liquid crystal display (LCD), and more
7 specifically to an illuminating backlight unit providing a planar light source
8 with homogenous luminance to improve the image quality of an LCD.

9 2. Description of Related Art

10 Liquid crystal displays (LCDs) are lightweight, slim and do not emit
11 harmful radiation, etc. so the LCD is becoming more popular than the CRT
12 display. The LCD basically has a liquid crystal panel and an illuminating
13 backlight unit. Since the liquid crystal panel cannot emit light, the illuminating
14 backlight unit is a necessary element of the LCD.

15 There are two types of illuminating backlight unit, generally speaking,
16 the edge-light backlight unit and the direct-light backlight unit. The edge-light
17 units are generally slimmer in size. However, the direct-light units have other
18 advantages, such as higher brightness and better brightness uniformity.

19 With reference to Fig. 7, the edge-light backlight unit comprises a
20 tubular lamp (60), a reflective sheet (62), a light guide plate (61) and an optical
21 assembly (not numbered). The tubular lamp (60) is mounted inside a reflector
22 (601). The light guide plate (61) has an edge (not numbered) exposed to the
23 tubular lamp (60). The light guide plate (61) is located between the optical
24 assembly and the reflective sheet (62). The reflector (601) projects light

1 radiated from the tubular lamp (60) into the light guide plate (61). The light
2 guide plate (61) is configured to transmit light from the tubular lamp (60)
3 across the viewing area and, with the help of the reflective sheet, effectively
4 deflect light towards the optical assembly. The optical assembly is composed of
5 a diffuser sheet (63) and prism sheets (64) and is located between a liquid
6 crystal panel (50) and a light guide plate (61). When the light passes through
7 the optical assembly, the light is smeared and dispersed, and forms a uniform
8 planar light source for the liquid crystal panel (50).

9 In the edge-light backlight unit, tubular lamp is mounted at the edge of
10 the light guide plate so the illuminating backlight unit is slim, generally
11 speaking. However, for large size LCDs, the edges of a light guide plate does
12 not provide enough light entrance area for forming a bright enough planar
13 illuminating surface. Especially for applications of a LCD TV, say for example.

14 With reference to Fig. 8, a conventional direct-light backlight unit in
15 accordance with the prior art comprises a case (70), multiple tubular lamps (71)
16 and a diffuser plate (72). The case (70) has a back (701) and a front opening
17 (702). The tubular lamps (71) are mounted inside the case, and align with the
18 back (701), as illuminating sources. The front opening (702) is covered by a
19 diffuser plate (72) to disperse and smear the emitting light from the lamps, and
20 to make it a homogeneous planar illuminating unit.

21 Without proper treatment with the diffuser plate (72), the lamps (71)
22 would be clearly visible from the backlight unit. Specifically, brighter areas
23 (not numbered) correspond to the lamps (71), and dimmer areas (not numbered)
24 exist between adjacent lamps (71). Therefore, the diffuser plate (72) must be

1 mounted on the case (70) over the opening (702). The diffuser plate (72), like a
2 screen, can disperse the light from multiple tubular lamps (71) evenly when the
3 diffuser plate is far enough from the tubular lamps (71). If the diffuser plate (72)
4 is placed too close to the lamps (71), the diffuser plate cannot disperse the light
5 properly, thus the bright and dim areas are clearly visible. Therefore, the direct-
6 light backlight unit cannot be made to be slim.

7 To further increase the brightness (or luminance) of the planar light
8 source, the back (701) of the case (70) is covered with a highly reflective layer
9 (703) to redirect part of the light that radiates backwards from the tubular lamps
10 (71) towards the front. The reflective layer (703) does not, however,
11 discriminately project light towards dimmer areas between the tubular lamps
12 (71). With reference to Fig. 6A, the brightness difference at the front opening
13 (702) is still obvious.

14 Thus concluding from above, the direct-light backlight units can provide
15 large size LCDs with high brightness. However, the multiple tubular lamps
16 (straight or looped in shape) emit light radiantly. Hence, in the viewing area on
17 the display where is direct in front of the lamps forms a brighter region, while,
18 area in between the lamps forms a dimmer region. The unevenly distributed
19 brightness across the viewing area of a liquid crystal display has an adverse
20 effect on the quality of image shown.

21 The present invention provides a direct-light illuminating backlight unit
22 for a liquid crystal display to mitigate or obviate the aforementioned problems.

23 **SUMMARY OF THE INVENTION**

24 An objective of the present invention is to provide a planar, direct-light

1 illuminating backlight unit with homogenous brightness to increase the image
2 quality of a liquid crystal display.

3 Another objective of the present invention is to provide a low profile,
4 slim direct-light illuminating backlight unit.

5 Other objectives, advantages and novel features of the invention will
6 become more apparent from the following detailed description when taken in
7 conjunction with the accompanying drawings.

8 **BRIEF DESCRIPTION OF THE DRAWINGS**

9 Fig. 1 is a partial cross-sectional view of a first embodiment of an
10 illuminating backlight unit and a separated liquid crystal panel in accordance
11 with the present invention;

12 Fig. 2 is a partial cross-sectional view of a second embodiment of an
13 illuminating backlight unit and a separated liquid crystal panel in accordance
14 with the present invention;

15 Fig. 3 is showing traces of light emitting from lamps as in the
16 illuminating backlight unit of that shown in Fig. 2;

17 Fig. 4 is an illustration of a shielding mask of an illuminating backlight
18 unit in accordance with the present invention, showing pattern of through holes
19 for light emitting;

20 Figs. 5A to 5D are bottom views of the illuminating backlight unit with
21 lamp arrangements in accordance with the present invention;

22 Fig. 6A is a plot of luminance across a distance perpendicular to the
23 lamps in direction of a direct-light backlight unit without reflective protrusion
24 on the back reflective surface;

1 Fig. 6B is a plot of luminance across a distance perpendicular to the
2 lamps in direction of a direct-light backlight unit with reflective protrusion on
3 the back reflective surface;

4 Fig. 7 is a cross-sectional view of an edge-light backlight unit assembly
5 with a liquid crystal panel in accordance with the prior art; and

6 Fig. 8 is an illustration of a direct-light backlight unit in accordance
7 with the prior art.

8 DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

9 A direct-light illuminating backlight unit in accordance with the present
10 invention uses a shielding mask to reduce brightness in the region that is
11 immediately in front of the light-emitting sources or lamps. Therefore, the
12 backlight unit has homogenous luminance across the viewing area.

13 With reference to Fig. 1, a first embodiment of the direct-light
14 backlight unit in accordance with the present invention attaches to a rear face
15 (11) of a liquid crystal panel (10). The illuminating backlight unit has a
16 thickness (not numbered), a case (20), at least one light-emitting source (22), at
17 least one shielding mask (30), a light emitting face (not numbered) and
18 optionally a diffuser plate (23).

19 The case (20) has a frame (21), a back (24), and a front opening (211).
20 The light emitting source (22) is mounted inside the case (20) align with the
21 back (24), and a liquid crystal panel (10) is mounted in front of the illuminating
22 backlight unit over the front opening (211) of the case (20). With further
23 reference to Figs. 5A to 5D, the light-emitting source (22) can be a straight
24 tubular lamp or looped tubular lamp. The looped tubular lamp can be either in

1 W shape, U shape, etc. On the light emitting face of a backlight unit, when the
2 lamp (22) radiates light, the further away from the lamp has the lower
3 illumination, thus forms uneven brighter regions (100) and dimmer regions
4 (101). The brighter regions (100) are areas immediately in front of the lamps
5 (22), and the dimmer regions are areas in between the lamps (101).

6 Each shielding mask (30) is mounted in the case (20) in front of the
7 lamp (22). With further reference to Fig. 4, the shielding mask (30) has a
8 pattern of opening that allow light to be emitted from the otherwise opaque
9 mask. Wherein the region immediately in front of the lamp has smaller opening
10 ratio and hence higher blockage to light. Furthermore, the region away from the
11 lamp has larger opening ratio and hence lower blockage to light. Thus, the mask
12 reduces the unevenness of luminance between the brighter region and the
13 dimmer region. Furthermore, the opening pattern of the shielding mask could
14 be a group of through holes. The holes (31) immediately in front of the lamp
15 (22) are small and increase in size, as they get further away from the lamp,
16 corresponding to a reducing incident illumination. The shielding mask (30) can
17 be either curved or flat, and could be made of opaque material with high
18 reflectance. The reflective inner surface of the shielding mask can reflect part
19 of the light that come directly radiating from the lamps and recycle the light
20 towards the back reflective layer (24) to be redirect towards the dimmer regions.

21 To further adjust the distribution of luminance across the light-emitting
22 face (viewing area), a diffuser plate (23) may be mounted on the frame (21)
23 over the front opening (211) to disperse the emitting light evenly. Therefore,
24 the illuminating backlight unit can provide a planar light source with

1 homogenous luminance. Since the luminance differences in between the
2 brighter areas (100) and the dimmer areas (101) on the light emitting face is
3 decreased by the shielding mask (30), the diffuser plate (23) can be mounted
4 closer to the lamp (22), and thus reduces the thickness of the illuminating
5 backlight unit. In addition, a diffuser sheet (not shown) or prism sheets (not
6 shown) can be laid on top to the diffuser plate (23) to further disperse the
7 emitting light from the backlight unit.

8 With reference to Fig. 2, a second embodiment of the illuminating
9 backlight unit is brighter than that of the first embodiment. The illuminating
10 backlight unit further comprises a reflective layer (not numbered) on the
11 bottom (24) of the case (20). The reflective layer is mounted on or formed
12 integrally with the bottom (24) and is composed of multiple reflective
13 protrusions (40). Each reflective protrusion (40) corresponds to a lamp (22) and
14 has one salient (42) and two inclined faces (41). The salient (42) is aligned with
15 the lamp (22), and each inclined face (41) project light onto an adjacent
16 dimmer area (101). Each inclined face (41) can be a flat, concave or convex
17 surface.

18 With reference to Fig. 3, light (L1) radiated backward from the lamp
19 (22) and the shielding mask (30) strikes the reflective layer and radiates
20 forward as reflected light (L2). The reflected light (L2) is projected towards the
21 dimmer area (101) by the inclined faces (41), which increases the luminance of
22 the dimmer area. Therefore, the light radiates from the lamp (22) can be more
23 effectively and evenly emitting through the front opening (light-emitting face)
24 of the case.

1 With reference to Figs. 6A and 6B, the illuminating backlight unit in
2 accordance with the present invention uses the reflective layer, so the
3 luminance distribution has shallower nulls than the prior art of conventional
4 backlight.

5 Based on the forgoing description, the backlight illuminating backlight
6 unit in accordance with the present invention uses the shielding mask to reduce
7 the brightness of the brighter areas and to decrease the difference of luminance
8 in between the brighter and dimmer areas. In addition, the shielding mask can
9 further reflect a portion of the light radiated from lamp towards the brighter
10 areas back to the reflective layer on the back and then project the reflected light
11 towards the dimmer areas. Therefore, a homogenous luminance distribution is
12 achieved across the light-emitting face (front opening). Further, the brightness
13 of the emitting light is first being averaged by the shielding mask and then the
14 reflective layer on the back, so the distance between the diffuser plate and the
15 lamp can be reduced, and thus reduces the total thickness of the illuminating
16 backlight unit.

17 Even though numerous characteristics and advantages of the present
18 invention have been set forth in the foregoing description, together with details
19 of the structure and function of the invention, the disclosure is illustrative only,
20 and changes may be made in detail, especially in matters of shape, size, and
21 arrangement of parts within the principles of the invention to the full extent
22 indicated by the broad general meaning of the terms in which the appended
23 claims are expressed.